REMARKS

Claims 1-34 have been cancelled without prejudice, and claims 35-56 have been added to the application. Accordingly, claims 35-56 are currently pending in this application. The specification has been amended to correct, *inter alia*, typographical errors previously identified, in an Office Action in U.S. Patent Application No. 09/387,338, of which the present application is a continuation.

Please consider the application in light of the above amendments. The Examiner is encouraged to contact the undersigned at (206) 287-3257 if there are any questions regarding these amendments.

Respectfully submitted,

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Enclosures:
  Appendix (Marked-up version of specification)
  Postcard

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Appendix – Specification
Marked to Show Changes

In the Specification:

On page 1, line 9, please delete the "CROSS-REFERENCE TO RELATED APPLICATIONS" and insert the following:

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. Patent Application No. 09/387,338, filed August 31, 1999 and now issued as U.S. Patent No. 6,270,647; which is a continuation International Patent Application No. PCT/US98/00126, which was filed with the PCT in the English language on January 16, 1998; which claims priority from U.S. Patent Application No. 08/940,670, filed September 30, 1997 and U.S. Patent Application No. 08/940,930, filed September 30, 1997.

On page 3, starting at line 9 and continuing through page 4, line 7:

In the electroplating of semiconductor wafers, an anode electrode is disposed in a plating bath and the wafer with the seed layer thereon is used as a cathode with the face~~d~~ of the wafer that is to be plated contacting an upper surface of the plating bath. The semiconductor wafer is held by a support system that also provides ~~be~~ requisite cathode potential to the wafer. The support system may comprise conductive fingers that secure the wafer in place and also contact the wafer in order to conduct electrical current for the plating operation.

During the electroplating process, the conductive fingers as well as ~~be~~ the semiconductor wafer are plated with the plating metal, such as copper. One potential problem that occurs in such a process is the build up of plating metal deposits on the conductive finger. These deposits may: 1) result in unintended attachment of the conductive finger while in contact with the wafer such that upon disengagement of the conductive finger with the wafer surface, some of the plated surface may tear away and fall off as particles; 2) introduce variability in the current being conducted through the contact and ultimately across the plated surface; and 3) result in small particles breaking off of the

deposits on the conductive finger or off of the wafer which may enter the plating bath, and ultimately lodge directly on the wafer surface during plating or contaminate subsequently plated wafers. These effects may each independently or in combination create irregularities in the plated surface or result in other defects in the wafer. Additionally, these effects may also contribute to reduced wafer to wafer uniformity.

On page 7, starting at line 11 and continuing through page 8, line 14:

In the illustrated system, the electroplating apparatus 70 is generally comprised of an electroplating chamber 75, a rotor assembly 80, and a stator assembly 85. The rotor assembly 80 supports the semiconductor wafer 55, a current control system 90, and a current thief assembly ~~35~~<u>95</u>. The rotor assembly 80, current control system 90, and current thief assembly 95 are disposed for co-rotation with respect to the stator assembly 85. The chamber 75 houses an anode assembly 100 and contains the solution 105 used to electroplate the semiconductor wafer 55.

The stator assembly 85 supports the rotor assembly 80 and it's associated components. A stator control system 110 may be disposed in fixed relationship with the stator assembly 85. The stator control system 110 may be in communication with the main electroplating control system 65 and may receive information relating to the identification of the particular type of semiconductor device that is being fabricated on the semiconductor wafer 55. The stator control system 110 further includes an electromagnetic radiation communications link 115 that is preferably used to communicate information to a corresponding electromagnetic radiation communications link ~~120~~ <u>125</u> of the current control system 90 used by the current control system 90 to control current flow (and thus current density) at individual portions of the current thief assembly 95. A specific construction of the current thief assembly 95, the rotor assembly 80, the stator control system 110, and the current control system 90 is set forth in further detail below.

In operation, ~~probes~~ <u>contacts</u> 120 make electrical contact with the semiconductor wafer 55. The semiconductor wafer 55 is then lowered into the solution 105 in minute steps by, for example, a stepper motor or the like until the lower surface of the semiconductor wafer 55 makes initial contact with the solution 105. Such initial contact

may be sensed by, for example, detecting a current flow through the solution 105 as measured through the semiconductor wafer 55. Such detection may be implemented by the stator control system 110, the main electroplating control system 65, or the current control system 90. Preferably, however, the detection is implemented with the stator control system 110.

On page 9, starting at line 8 and continuing through line 21:

Plating solution is supplied to the processing chamber 75 through a fluid inlet 215 that opens to the bottom of lever processing cup 205 the plating fluid fills chamber 75 and provides a conductive path between the anode 100 and the semiconductor wafer 55 to thereby form a complete electroplating circuit. A continuous flow ~~loaf~~ of the plating fluid into the chamber 75 is preferable. As such, processing solution must be removed from the processing chamber 75 at the same rate that it is supplied through the inlet 215. To this end, the processing cup 205 is disposed within a reservoir bowl 220. Plating solution fills chamber 75 through inlet 215 and overflows from the reactor cup 205. The overflowing fluid flows over the upper rim of cup 205 and into the interstitial region between the outer perimeter of cup 205 and the inner perimeter of reservoir bowl 220. Processing solution is allowed to exit from the reservoir bowl 220 through a fluid outlet assembly 225. The fluid outlet assembly 225 is preferably comprised of an outlet to 230, an external electrode 235, and a control valve 240 disposed in the fluid path between the reservoir bowl 220 and the external electrode 235.

On page 10, beginning at line 2 and continuing through line 17:

After the electroplating process is completed, the semiconductor wafer 55 is removed and in-situ cleaning of the contact electrodes 120 may be conducted. To this end, switch 245 is opened while switch 250 is closed to thereby connect supply 280 to the contact electrodes 120 and the external electrode 235. This effectively makes the electrode contacts 120 function as anodes and the external electrode 235 function as the cathode. Processing fluid flow from ~~being~~ reservoir bowl 220 is controlled by control valve 240 to maintain a level of the processing fluid in the reservoir bowl 220 at a level which maintains

electrical contact through the plating solution between the electrodes 120 and external electrode 235. The resulting reverse current may be provided at a voltage potential in the approximate range of 0.1-100 volts, alternatively in the approximate range of 0.1 - 20 volts, or alternatively in the approximate range of 1-10 volts between the auxiliary electrode and the wafer contact electrodes. The voltage potential may vary dependent on the number of semiconductor workpieces that are processed through a normal operating cycle, etc.

It should be noted that the two supply configurations illustrated here ~~is~~ are merely for illustrative purposes. A single supply capable of providing both the plating and cleaning power may be used with any suitable switching configuration.

On page 11, beginning at line 22 and continuing through page 12, line 10:

An alternative placement of an external electrode for in-situ cleaning is illustrated in Fig. 3. In this embodiment, the external electrode 270 is disposed at the bottom of reservoir bowl 220 and is in the form ~~all~~ of an annular electrode disposed about the inlet tube 215.

A still further alternative placement of the external electrode is illustrated in Fig. 4. In the illustrated embodiment, the external electrode ~~280~~ 281 is disposed about the outer upper periphery of the processing cup 205. Placement of the external electrode 280 at the outer upper periphery of the processing cup 205 increases the likelihood of a proper electrical connection through the fluid during cleaning operations. Additionally, since the external electrode 280 is disposed in a region having high velocity processing fluid flow, any residue particulates that may inhibit electrode cleaning operations may be wiped from the electrode ~~280~~ 281 by the processing fluid.

On page 13, beginning at line 11 and continuing through line 17:

The use and placement of the auxiliary electrodes allows for the particles and ~~contaminates~~ contaminants in the plating bath solution to be segregated and removed from the reaction system, thus preventing the particles and contaminates from lodging onto subsequently processed wafers and thereby creating irregularities on those surfaces. The auxiliary electrode and filtering configuration also provides a convenient means for cleaning

the finger electrode and plating solution with minimal intrusion into the reactor system as compared with manual replacement of the finger electrode.

On page 16, beginning at line 4 and continuing through line 17:

Bowl bottom 619 is configured so as to have a large open area allowing the free transfer of fluid therethrough. In the preferred embodiment, this is achieved by the structure shown in Fig. 6, wherein the process bowl bottom 619 is composed of crossbars 626 which intersect at bowl bottom center plate 639 creating fluid return openings 638. Bowl bottom center plate 639 is provided with bowl bottom opening 627 to allow fluid inlet line 625 to pass therethrough. In the illustrated embodiment, the bowl sides 617 below the reservoir top 618 are also similarly constructed so that bowl sides below reservoir top 618 are composed of 4 rectangular sections which then turn inward towards bowl bottom center plate 639 intersecting thereat. Such a configuration allows for a high degree of fluid flow to pass through the bowl lower portion which is disposed within reservoir 604. Thus, in operation, process fluid is provided through process fluid inlet line 625 and discharges through fluid outlet openings 628 within the lower part of the cup assembly 620. By virtue of cup filter ~~620~~630, fluid entering the fluid inlet plenum 629 is distributed across the plenum and then flows upward through filter 630 to the bottom of anode 634.

On page 17, beginning at line 5 and continuing through line 11:

As a further advantage, the location of the cup filter 630 and anode 634 within the cup 621 provides an even distribution of fluid inlet into the cup. The even distribution beneficially assists in providing a quiescent fluid surface at the top of cup 621. In like manner, maintaining a constant distance between the outer wall of cup 636 and the inner wall of bowl 616 in providing the overflow gap 632 will assist in providing an even flow of fluid out of cup 621 and into the reservoir 604. This further beneficially assists in providing the desired ~~quiescence~~ quiescent state of the process fluid at the top of cup 621.

On page 18, beginning at line 3 and continuing through line 13:

Turning now to Fig. 7, a representational process bowl assembly is shown in cross section along with a representational workpiece support 401 to illustrate an entire electroplating assembly comprising an auxiliary electrode 1015 (shown in Figure 6). Plating chamber assembly 603 is preferably provided with levelers 640 (only one of which is shown in this view) which allow the plating chamber assembly to be leveled relative to the top of reservoir 618. The levelers may comprise jack screws threaded within the edge of module deck plate 666 and in contact with the process module frame 606 so as to elevate the process bowl assembly 603 relative to the process module 20. The process bowl assembly 603 is preferably provided with three such bowl levelers distributed about the bowl periphery. This allows for leveling in both an X and Y axis or what may be generically described as "left and right leveling and front and rear leveling."

On page 19, beginning at line 6 and continuing through line 14:

The process bowl assembly 602 is more preferably provided with an additional height adjuster for the anode 634. Anode height adjuster ~~646~~ 648 is formed by mounting the anode 634 on the threaded anode post 664. A threaded anode adjustment sleeve 663 is used to connect the threaded upper end of inlet line 625. Anode adjustment sleeve 663 is provided with sleeve openings 668 to allow fluid to pass from fluid outlet openings 628 into the inlet plenum 629. The space between the bottom of anode post 664 and the upper end of fluid inlet line 625, and bounded by the anode adjustment sleeve 663, defines a fluid outlet chamber 662. Fluid outlet chamber is of variable volume as the anode post 664 moves upward and downward with height adjustment of the anode 634.